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A Detailed Study of Indoor Air Quality (IAQ)

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Abstract: Clean environmental air is a basic right for all humans. Indoor air quality is particularly important to humans since we spend up to 90% of time indoors. While most individuals understand that outdoor air quality is important to their health status, many are unaware of the detrimental effects indoor air pollution can potentially have on them. There has been a strong correlation between air quality and health. Indoor air pollution is an international health concern because people spend a majority of their time indoors. Children are at a higher risk of health problems from pollutant exposure, especially because air in the child breathing zone is more polluted than it is in the adult breathing zone. Pollutants of concern include biological contaminants, combustion pollutants, volatile organic compounds, and radon and other soil gases. All of these toxicants can be minimized or abated. Awareness of these issues is a critical first step in improving air quality in places where people live.

Keywords: Biological contaminants, combustion pollutants, volatile organic compounds, radon, asbestos, child breathing zone.

I. INTRODUCTION

In recent years, indoor air pollution has become an international health concern. Research has shown that people spend about 90% of their time indoors and 75%of their time indoors in their homes. Some people such as children, the elderly, and infirm spend most or all of their time indoors. Research also indicate that pollutant levels can be higher indoors than outdoors .Concerns about indoor air quality have led to indoor air management becoming a new consumer skill. Steps involved in indoor air management include identifying a pollutant of concern, controlling it at its source, and if that fails, mitigation.

II. PARAMETERS AFFECTING IAQ

- Rate of exchange of air from outdoors (ventilation).
- Concentration of pollutants in outdoor air.
- Rate of emission from sources indoors.
- Rate of removal of pollutants (Sinks)
- Indoor temperature.
- Indoor humidity.
- Age of indoor structure.
- Type of foundation soil.

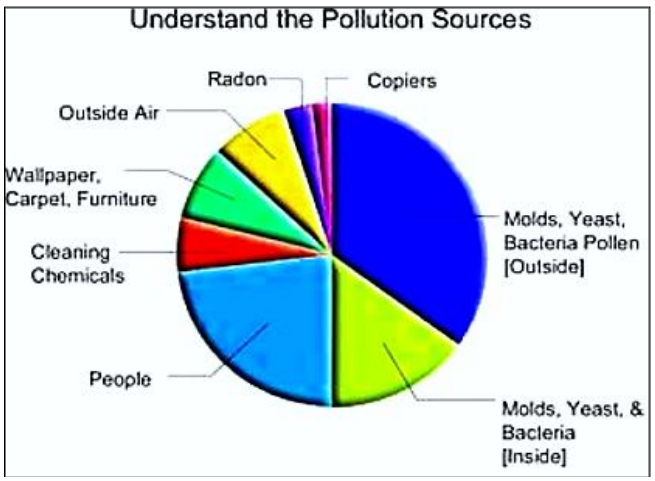

Fig. 1 Pollution Sources

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III. RESIDENTIAL INDOOR AIR POLLUTANTS

Residential indoor air pollutants include

- Biological contaminants,
- Volatile organic compounds,
- Radon and other soil gases,
- Combustion pollutants,
- Lead and Asbestos.

(i) Biological contaminants

- Biological contaminants include mold, viruses, bacteria, pollen, animal dander and dust mites.
- Moisture plays an essential role in the presence of biological contaminants.

(ii) Volatile organic compounds

- Volatile organic compounds (VOCs) are gases released from some solids or liquids at room temperature.
- VOC sources include building products, paints, strippers, solvents, wood preservatives, air fresheners, hobby supplies, pesticides, dry-cleaned clothing, cosmetics, cleaning products, air fresheners, vinyl flooring and more.
- Common examples of VOCs that may be present in our daily lives are: benzene, ethylene glycol, formaldehyde, methylene chloride, tetrachloroethylene, toluene, xylene, and 1,3-butadiene.
- Many VOCs found in household air have adverse health impacts, including eye, nose, and throat irritation, asthma exacerbation, lung, kidney, and central nervous system damage and cancer.

(iii) Radon and other soil gases

- Uranium and radium are solid elements. Uranium exists in soils all over the world. The radioactive decay process causes uranium to decay to uranium. But radium decays to a gas, radon.
- Radon is a radioactive gas that has no odor, taste or color.
- Radon moves easily through permeable soils, such as gravelly and sandy soils. Cracks in a house foundation and other openings, such as those around pipes that penetrate a house foundation, serve as radon pathways into the house.
- Radon continues in the decay process once it is inside a home. Radon's decay products are lead, polonium and bismuth. These decay products become attached to microscopic particulates in house air, which are inhaled by people in the house and lead to lung cancer.

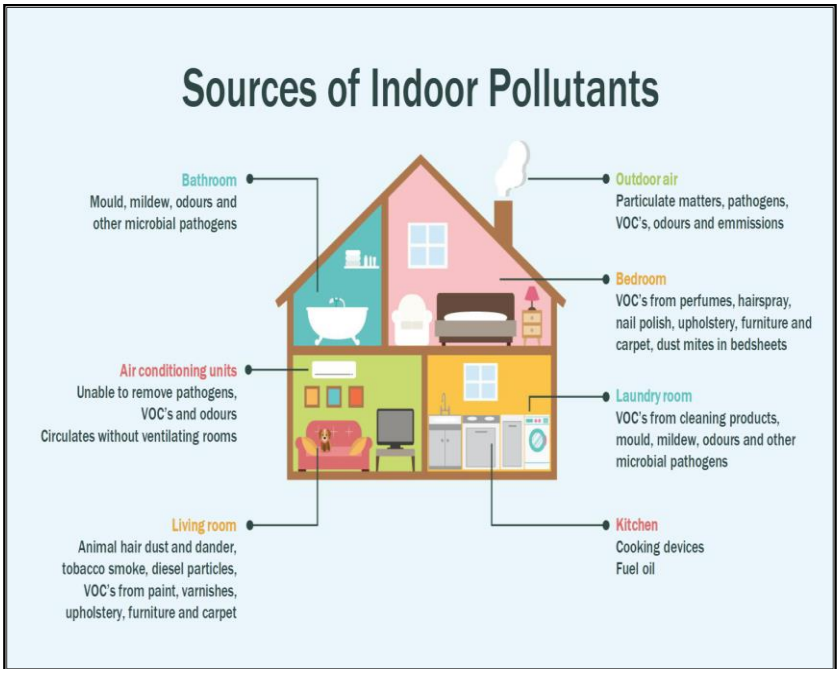

Fig. 2 Source of Indoor Air Pollutants

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(iv) Combustion products

- Combustion products consist of nitrogen oxides, sulfur dioxide, carbon monoxide, respirable particulates and water.
- When a person breathes air that is polluted with CO, CO binds with hemoglobin and carboxyhemoglobin is formed, which prevents oxygen from getting to the brain.
- At low levels, this causes tiredness and dizziness. At higher levels, gradual suffocation and death occur.

(v) Lead

- Lead is also present in many household products, including slow cookers, lipstick and other cosmetics, house keys, hair dyes faux leather purses, sandals and wallets etc.,
- Negative health impacts from lead exposure include reduced IQ levels, behavioral problems, organ damage, anemia, convulsions and death.

(vi) Asbestos

- The term asbestos refers to naturally occurring silicate minerals that are heat-resistant and fibrous. The fibers are soft and can be easily incorporated into building materials.
- Exposure to asbestos occurs through inhalation of fibres in indoor air of housing and buildings containing friable (crumbly) asbestos materials.
- All types of asbestos cause lung cancer, mesothelioma, cancer of the larynx and ovary, and asbestosis (fibrosis of the lungs).

(vii) Secondhand Smoke

The awareness of smoking and its adverse effects is as widespread today as at any point of time in history. Globally, smoking remains a highly prevalent lifestyle choice. Secondhand smoke exposure is a leading public health problem. Approximately 1 nonsmoker dies from secondhand smoke exposure for every 8 smokers.

IV. THE CHILD BREATHING ZONE

Toddlers crawl on the floor and young children walk, run, and play on the floor. These factors cause the breathing zone of children to be much lower (upto 3 feet from the floor). This zone is known as the child breathing zone (CBZ). Walking-induced turbulence in a room causes resuspension of respirable particulates. IAQ can be significantly worse in the CBZ than in the adult breathing zone (ABZ)

Children face higher risks than adults do from being exposed to indoor air toxicants and from health problems caused by such exposure .This is because children breathe larger amounts of air per body size when compared to adults. Young and older infants and young children breathe through their mouths than adults do. This difference in breathing patterns is likely to increase a child's risk of exposure to respirable particulates.

V. AIR QUALITY INDEX (AQI)

Air Quality Index or AQI is an indicator to understand the quality of air. It shows the pollution status in the air with a numeric scale ranges from 0 to 500 as well as with different color indicators. The index represents how clean or polluted the air is in a specific area.

Five pollutants are usually taken into consideration to generate the air quality index. They include particulate matters (PM), ground-level ozone (O3), carbon monoxide (CO), sulfur dioxide (SO2) and nitrogen dioxide (NO2).

How AQI works

AQI runs on a scale of 0 to 500 and also indicated by colors. Lower AQI value represents the clean air, and a higher AQI value represents the polluted air. An AQI below 50 is considered a good quality of air, and it becomes unhealthy when it crosses 100. If the AQI is more than 200, then the pollution level is very high. An AQI of 300 and up indicates dangerous air quality.

VI. UNDERSTANDING THE AQI

The main aim of AQI is to master the air quality in the local area. Here are some of the air pollutions levels indicated.

Good: The AQI levels are below 50. It is a state which indicates good air quality. There is low pollution and there at risk at this stage.

Moderate: The level is ranges from 51 – 100. In this condition, there is tolerant pollution. There is no high risk to the environment at this stage.

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Unhealthy for sensitive groups: Some people are vulnerable to air quality. They will start developing complications when the air quality reaches between 101 and 150.
Unhealthy: It is a condition where the experts consider the air quality is unhealthy. It ranges from 151 to 200 AQI. It indicates the air condition is at harmful levels. Something should be taken to purify the air before your family members can breathe it.
Very unhealthy: At this stage, the AQI ranges from 201 to 300 AQI. The condition can pose several risks to human beings. Experts warn of several pollutants in the air.
Hazardous: In this stage, the AQI will range between 301 and 500. At this stage, there are a lot of particles in the air that pose a danger to human life.

VII. INDOOR AIR POLLUTANTS AND THEIR HEALTH EFFECTS

Pollutant	Source	Adverse Health Effects
Volatile Organic Compounds (VOCs)	Solvents and chemicals, perfumes, hair spray, furniture polish, glues, air fresheners, moth repellents, wood preservatives, second-hand tobacco smoke	Headaches, eye/nose/throat irritation, nausea and loss of coordination, cancer
Second-hand Tobacco Smoke	Cigarettes, cigars, pipes, etc.	Many detrimental health effects, including cancer
Pesticides	Plant and animal pesticide products	Not generally safe, even if used according to directions. High risk for children, pregnant women, elderly, asthma patients
Biological Pollutants	Plant pollen, dust mites, animals (droppings and urine), pet hair, insects, fungi/mold spores, parasites, some bacteria and viruses	Triggers asthma and allergies; infectious diseases
Formaldehyde	Gas emitted by carpets, particleboard, insulation foam	Irritation to the eyes and nose, may promote allergies, cancer
Asbestos	Old linoleum flooring, old walls/ceilings (with old insulation). Hazardous when fibers are released into the air (e.g., by demolition)	Fibers enter the lungs and may cause cancer
Radon	Gas released by soil. More common in enclosed or poorly ventilated spaces, especially basements or crawlspaces	Lung cancer

VIII. WAYS TO IMPROVE INDOOR AIR QUALITY

(i) Ventilation: Indoor air is typically two to five times more polluted than outdoor air, and bringing some of that fresh air in is one of the best ways to improve indoor air quality.
There are 2 types of ventilation:
Natural ventilation: Utilizes the pressure difference of outside air & circulation of air.
Mechanical ventilation: Uses air moving equipment (Fan) to generate pressure difference for air flow.

(ii) Humidity: As important as ventilation is, a well-sealed home is essential for preventing the moisture and humidity buildup that can cause mold to grow. Moisture plays an essential role in the presence of biological contaminants.

(iii) Cleanliness: A clean home is a healthier one. Mold, fungi and other pests thrive in dark, damp, crowded spaces. In dirty environments, lingering dust and dander get circulated into the air and cause health problems. Keeping indoors clean is one of the best ways to maintain air quality at a healthy level.

(iv) Purification: Purifying the indoors is a quick and easy way to rid it of airborne microbes, and there are several ways to do this, including using air scrubbers.

As flash points the following things can be followed to effectively mitigate the IAQ problems
1. Use safe household cleaners and products.
2. Use safe paint and safe home remodel materials.
3. Don't smoke indoors.

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4. Wash bedding frequently.
5. Clean your fabrics regularly.
6. Use clean air plants.
7. Control the moisture.
8. Clean your air conditioner and heating systems.
9. Use an air purifier.

IX. CONCLUSION

The most effective strategy for controlling indoor air pollution is to control the problem at its source. Ventilation is the most important, especially in the case of moisture. Expel moisture to the outside through exhaust fans that are vented to the outdoors. In the case of combustion pollutants, regular servicing of heating systems and other appliances that are combustion based is necessary. Radon pollutant can be controlled through mitigation in existing homes and with radon-resistant construction techniques in new homes. Exposure to some VOCs, which are present in building materials, paints, strippers, and other substances, can be hazardous to human health. Adequate ventilation should be provided when using these materials. Low or no-VOC emitting products are now available and should be considered as safer alternatives. Lead and asbestos present in older homes and apartments pose considerable health risks to humans. Only trained professionals should perform abatement or encapsulation of both materials. Children are at a higher risk of health problems from pollutant exposure, especially because air in the child breathing zone is more polluted than it is in the adult breathing zone. Awareness of these issues is a critical first step in improving air quality in homes and apartment. Consumer education on this topic is necessary to inform the public about this issue.

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